Small Business Innovation Research/Small Business Tech Transfer

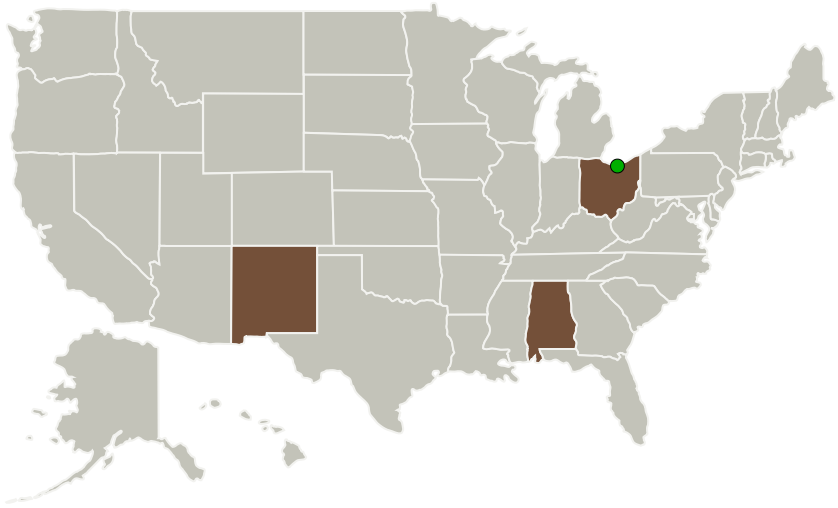
Integrated Reacting Fluid Dynamics and Predictive Materials Degradation Models for Propulsion System Conditions, Phase I

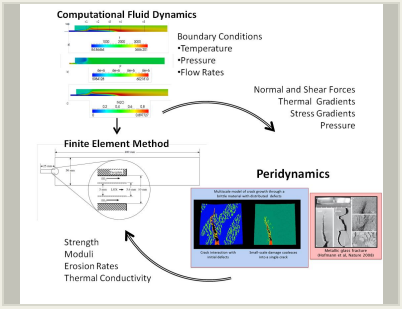
Completed Technology Project (2015 - 2016)

Project Introduction

Computational fluid dynamics (CFD) simulations are routinely used by NASA to optimize the design of propulsion systems. Current methods for CFD modeling rely on general materials properties to determine fluid structure interactions. This introduces uncertainty when modeling extreme conditions, where materials degrade and properties may change as a consequence. This also limits the use of CFD as a modeling tool to assist in material selection and specification. CFDRC in partnership with Sandia National Laboratories proposes to develop a computational materials model to simulate degradation of a ceramic matrix composite material under the high temperature, high velocity flow conditions of the propulsion environment. The objective is to provide a computational tool to assist NASA in the selection and optimization of propulsion system materials and to predict material degradation and failure throughout the service life in extreme conditions. During Phase I the team will demonstrate a mesoscale materials model based on peridynamics, a theory of continuum mechanics that can describe fracture and defect progression at the level of the microstructure. Peridynamics provides a theoretical framework to dynamically simulate fracture and mechanical erosion at the mesoscale, where properties such as tensile strength and toughness are affected by features of the microstructure and composite design. The proposed modeling scheme use CFD to establish the thermal-mechanical stresses imposed at the boundaries of the structure. Peridynamics simulations will be used to determine the evolution of the macroscale properties as a function of microstructure, damage and boundary conditions. Methods to link time and condition dependent materials properties with the CFD system will be evaluated.

Primary U.S. Work Locations and Key Partners





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Completed Technology Project (2015 - 2016)

Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio
Sandia National Laboratories(SNL)	Supporting Organization	R&D Center	Albuquerque, New Mexico

Primary U.S. Work Locations	
Alabama	New Mexico
Ohio	

Project Transitions

June 2015: Project Start

June 2016: Closed out

Closeout Summary: Integrated Reacting Fluid Dynamics and Predictive Materia ls Degradation Models for Propulsion System Conditions, Phase I Project Image

Closeout Documentation:

- Final Summary Chart Image*(https://techport.nasa.gov/file/139130)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

CFD Research Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

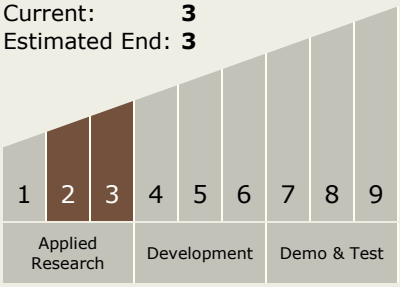
Carlos Torrez

Principal Investigator:

Bryce Devine

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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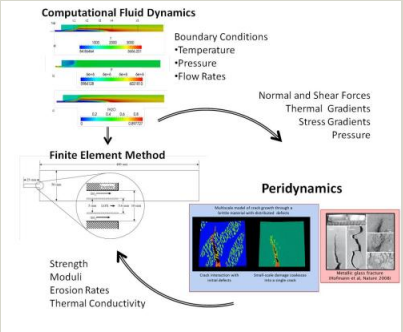
Images



Briefing Chart Image
Integrated Reacting Fluid Dynamics and Predictive Materials Degradation Models for Propulsion System Conditions, Phase I *(https://techport.nasa.gov/image/137016)*

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.1 Materials
    - TX12.1.2 Computational Materials

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System